GC43C-1213

MODEL COMPLEXITY OF GLOBAL CLIMATE:

Could Arrhenius have foreseen the hiatus?

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1. Model Complexity of Climate: The Concept

- Model complexity is like computational complexity: problems can be easy, hard, or even impossible.
- Hard climate problems: forecasting weather in 50 days or 5-year climate in 50 years, estimating recent Antarctic ice change, etc.
- Easy climate problems: comfortable latitudes, best season to go to the Bahamas, forecasting 65-year climate in 2100, etc.

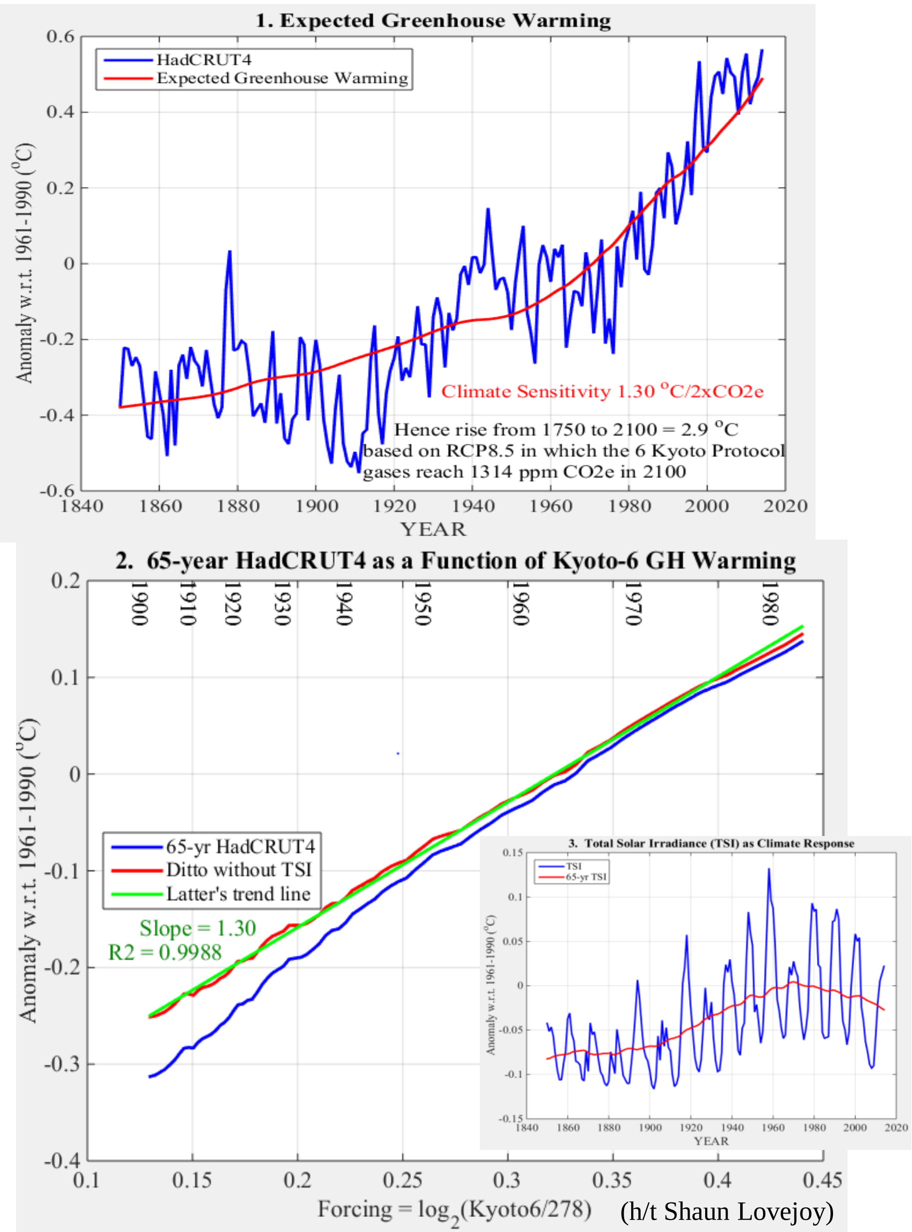
2. Metrics for Climate Models

- Properties of questions about systems.
  1. Desired precision of answer (± 2 °C, ± 21 days, etc.).
  2. Resolution (averaged over 5°×5° cells, 65 years, etc.).
  3. Scope of validity (modern weather forecasting has a scope on the order of ten days).
- Properties of models of systems:
  1. Number of geophysical datasets.
  2. Number of parameters. Two types:
     i. Standard (from the literature)
     ii. Fitted (least-squares estimate).
  3. Forecasting skill. When trained on data only up to 1940, how well does the model forecast 1940-1980, say?

3. Methodology

- Whereas models frequently use mathematical functions, all curves in this work with one exception are based on geophysical data.
- The exception is a regular 20-year oscillation clearly visible in HadCRUT4 since 1880, and in Central England Temperature much earlier. We idealize it as a slightly left-leaning triangle wave.
- The skill of a model is estimated by fitting its parameters to data up to some year (1925, 1965, etc.) and comparing its projections with what actually happened.

4. 65-year HadCRUT4

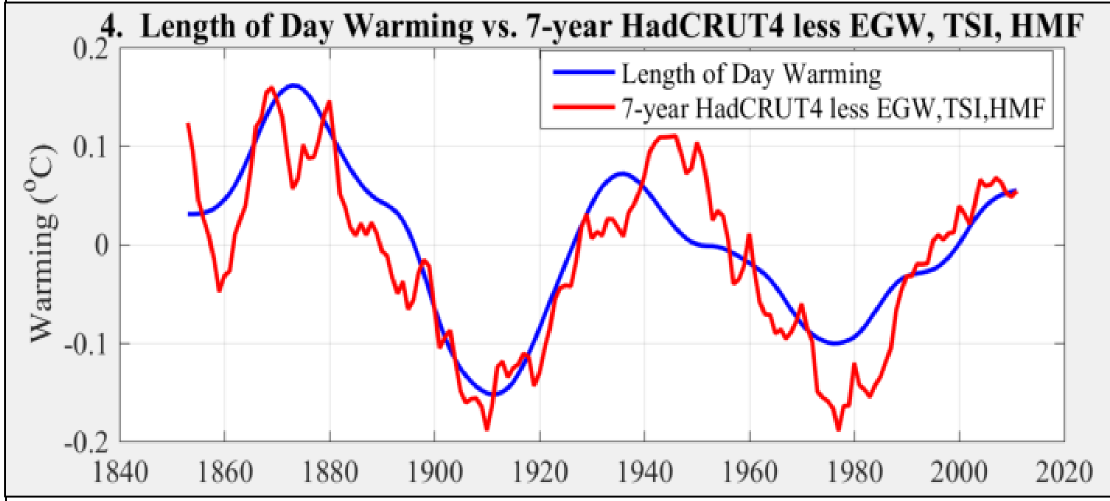


- Global mean surface temperature (blue in 1) looks quite random.
- The expected rise in temperature due to greenhouse warming (red in 1) looks much simpler.
- But so does GMST when smoothed to a 65-year moving average and plotted against the Arrhenius greenhouse law (blue in 2).
- This removes all natural variability except TSI. Use std parameters: A = 0.3, λ = 0.8.
- The red curve removes TSI (Fig. 3) too, leaving a very straight line, R2 = 0.9988!
- *Its slope is the basis for the red curve in 1.*
- Model complexity: 2 datasets, 1 fitted parameter (clim. sens.) & 2 std. yields a very coarse (65-year) forecast with clear high skill to 1983 based on e.g. 1900-1940

5. 7-year climate

- Removing Expected Global Warming and TSI permits close examination of the residual at a finer resolution of a 7-year moving average.
- A striking relationship with Length of Day emerges.
- The timing of the features suggests a causal relation from LOD to climate.
- (But why does climate keep warming during 1930-1940?)

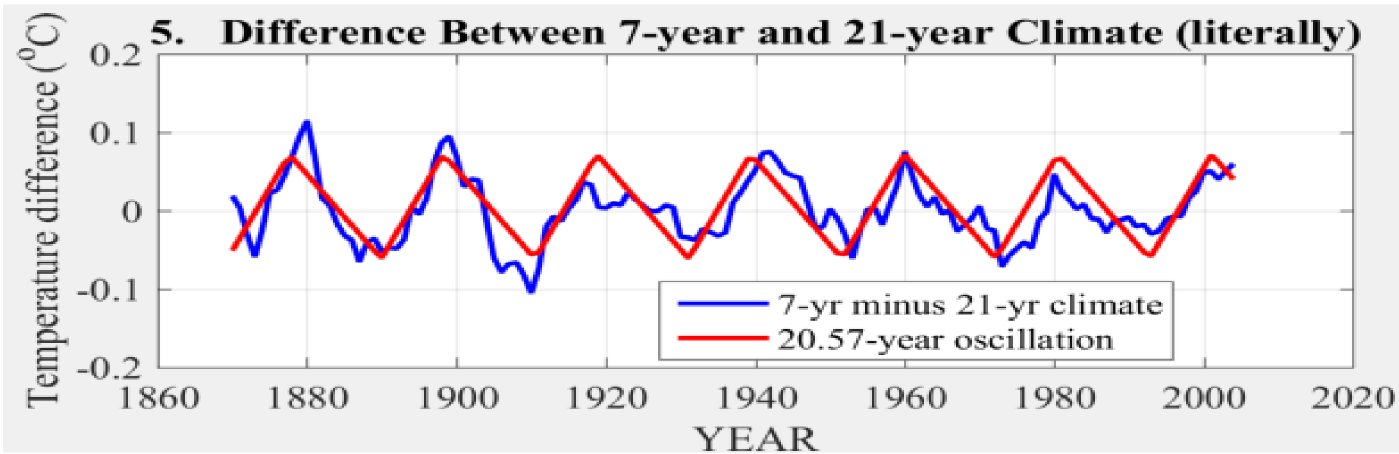
We developed a simple model of how fluctuating LOD can release or withdraw magma and computed how it influenced sea surface temperature, the blue curve in Figure 4.



THE CENTRIFUGAL VOLCANISM HYPOTHESIS

Faster rotation increases magma flow into the ocean. (h/t Ryan Abernathey)
It also increases pressure in magma chambers, which conceivably could explain the continued magma flows during 1930-1940 (up) and 1970-1980 (down).
Modeling the physics so far has explained only about half of those flows.

6. 21- vs. 7-year Climate: The Difference



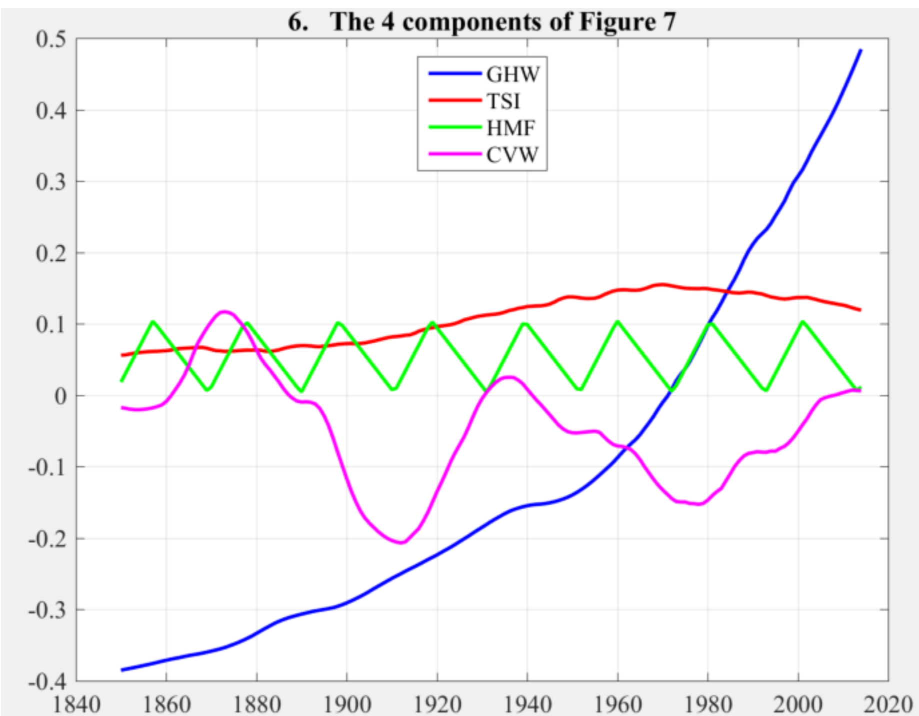
- Whereas 21-year smoothing completely removes any 21-year periodicity in HadCRUT4, 7-year climate preserves sinc(7/21) = 82.7% of it.
- Hence the difference acts as an excellent bandpass filter for any 21-year oscillation.
- The 6 peaks at 1880, 1900, 1920, up to 1980 clearly stand out.
- 4 parameters: period, amplitude, phase, asymm
- The 2001-2011 decline as the hiatus? (HadCRUT4 has been rising since 2012).

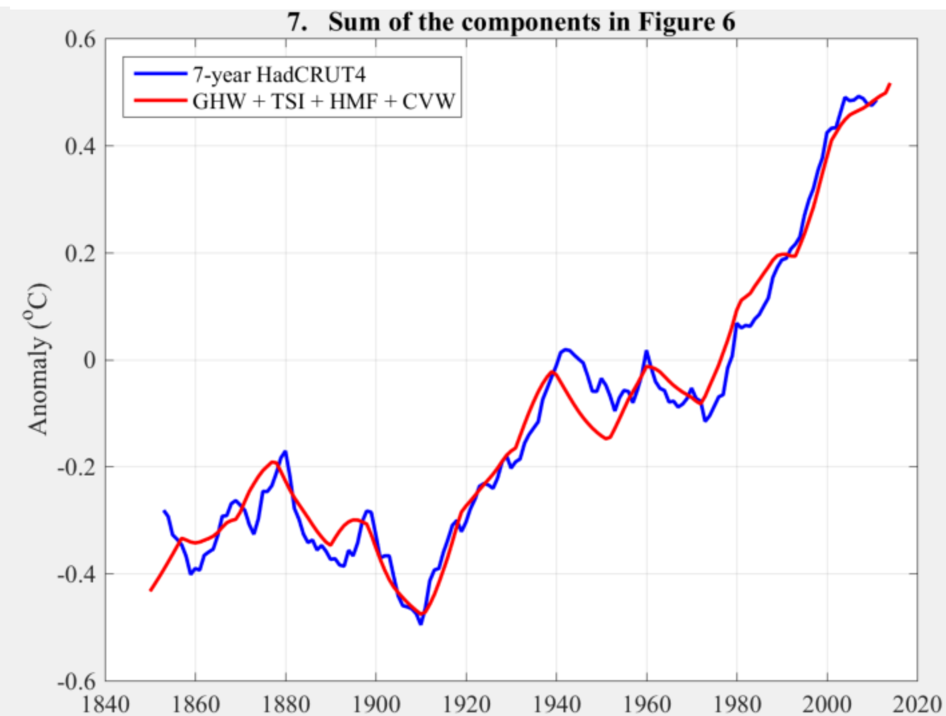
THE HELIOMAGNETOSPHERIC NUCLEATION HYPOTHESIS

At the peak of odd-numbered solar cycles Bz turns south and couples with Earth's magnetic field. Cosmic rays enter and nucleate clouds to increase cloud cover and albedo, thus reducing temperature.

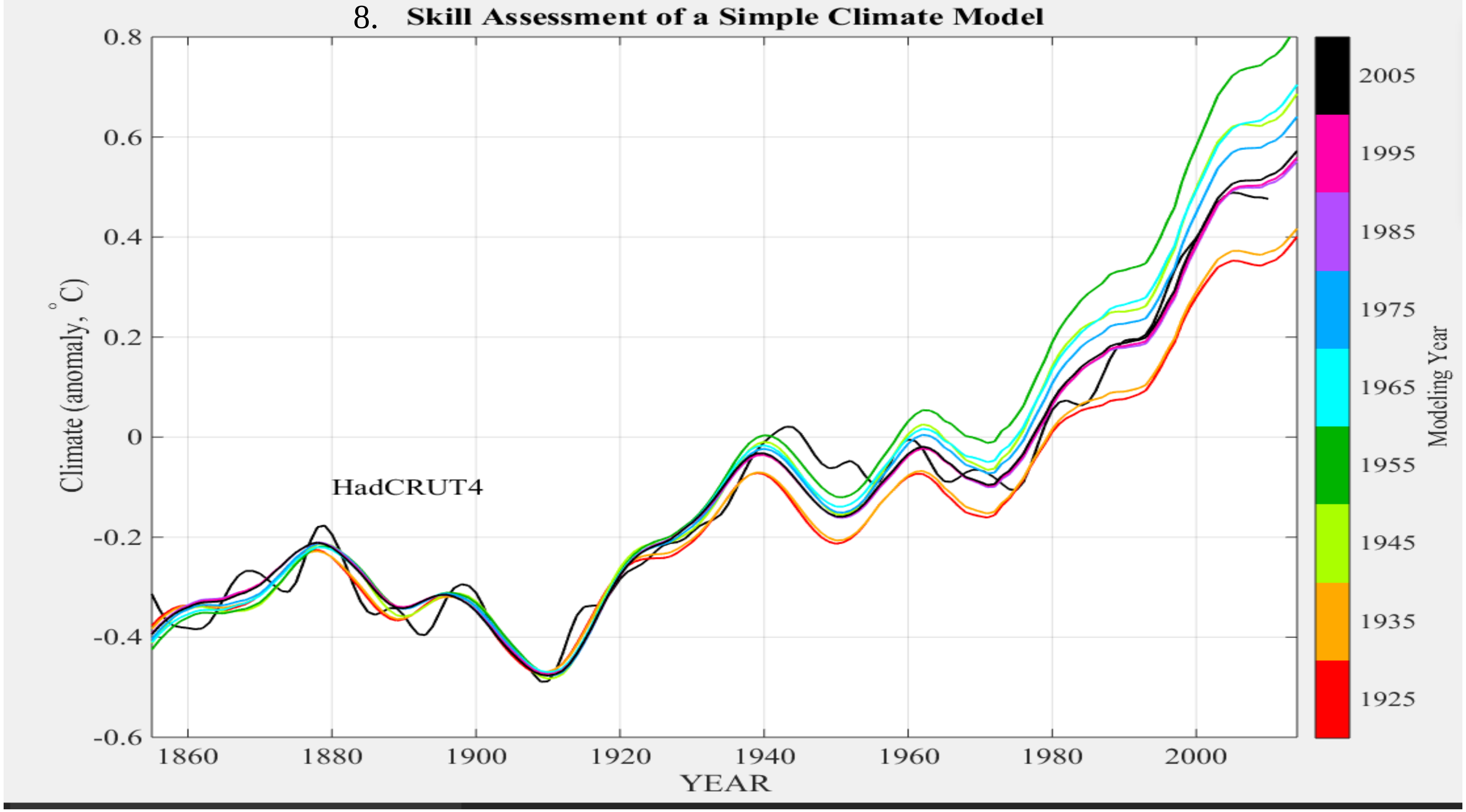
7. Summing the components

- The components found and explained on the preceding pages are shown individually in Figure 6 and summed as the red curve in Figure 7.
- GHW is GreenHouse Warming, TSI is 65-year Total Solar Irradiance, HMF is correlated with the Heliomagnetic Field, and CVW is our hypothesized Centrifugal Volcanism Warming of the ocean.





8. Forecasting Skill



- We based a model on CO_2, Length of Day, and the 20-year solar period. We fitted the model to the data from these and 5-year HadCRUT4 up to the color-coded year 1925, 1935, etc.
- Before 1945, estimates were low, thereafter high, converged close to HadCRUT4.
- Even in 1925 Arrhenius (d. 1927) could foresee the pause during 2001-2011.

9. Future work

1. More detailed geophysical model of centrifugal volcanism. Develop a reasonable hypothesis explaining the continued warming 1930-1940.
2. More cloud and cosmic ray data needed for the 20-year period.
3. Analyze the Representative Concentration Pathways (8.5, 6, 4.5, 2.6) for their respective impacts on skill. Claim: RCP8.5 pathway delivers the most skill with our existing methodology, more work is needed to improve skill in the event of any of the other GHG outcomes.

10. References

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